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Relationships Between The Yo-Yo Intermittent Recovery Test Level 2 And Match-Running Performance Differ Across Playing Position In Elite Youth Soccer Players

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Abstract

The aim of the present study was to examine the relationships between the Yo-Yo intermittent recovery test level 2 (YYIR2) performance and match-running performance across playing positions in elite youth soccer players. Participants were 129 players (age = 17.0 ± 0.8 years) from 11 professional soccer academy teams. A Global Positioning System was employed to analyze 26, 11-a-side matches for: total distance covered; distance covered high-intensity running (HIR, 3.6 to 4.4 $m \cdot s^{-1}$), very high-intensity running (VHIR, 4.5 to 5.3 $m \cdot s^{-1}$), sprinting (> 5.3 $m \cdot s^{-1}$) and very high-intensity activity (VHIA, calculated as VHIR plus sprinting); distance covered by high power (HP, 20-35 $W \cdot kg^{-1}$), elevated power (EP, 35-55 $W \cdot kg^{-1}$), maximal power (MaxP, > 55 $W \cdot kg^{-1}$) and MP≥35 (calculated as EP plus MaxP); and number of accelerations (> 2 $m \cdot s^{-2}$) and decelerations (< 2 $m \cdot s^{-2}$). The YYIR2 test was conducted within three weeks of the matches. When all players were included, the YYIR2 distance was positively associated with all match-running performance variables (r = 0.36-0.47, all P < 0.01). When each playing position was analyzed separately, the YYIR2 distance was significantly related to: total distance in central defenders (CD) (r = 0.47, P < 0.05); VHIA in all playing positions except CD (r = 0.49-0.69, all P < 0.05); MP≥35 distance in all playing positions (r = 0.52-0.82, all P < 0.05); and number of accelerations and decelerations in defenders (r = 0.53-0.83, all P < 0.05). These findings suggest that the YYIR2 is a valid test for the assessment of match-related physical fitness in elite youth soccer players regardless of playing position. However, the relationships between the YYIR2 and match running performance variables are playing position-dependent except for when the metabolic power approach (MP≥35) is employed.

Keywords: Association football; endurance fitness; field test; match analysis; young players

Abbreviations

Central defenders (CD), central midfielders (CM), elevated power (EP), high-intensity running (HIR), high power (HP), maximal power (MaxP), strikers (ST), very high-intensity activity (VHIA), very high-intensity running (VHIR), wide defenders (WD), wide midfielders (WM), Yo-Yo intermittent recovery test level 2 (YYIR2).

Introduction

The ability to perform intermittent, high-intensity exercise for prolonged periods is a key component of competitive soccer [7, 35] and as a result, maximal field tests have been proposed in order to monitor players' physical capacity [2, 3, 6, 13, 21]. The Yo-Yo intermittent recovery test level 1 and 2 (YYIR1 and YYIR2) have been developed to examine the intermittent endurance ability of soccer players in field conditions [2]. The YYIR1 evaluates an individual's ability to repeatedly perform intermittent activities with a high aerobic component towards the end of the test and has been widely utilized in youth soccer [2]. The construct validity of the test as a measure of match-running performance has previously been demonstrated and these studies show significant relationships between the YYIR1 distance and both total match-running distance and distance covered at high-speeds [7, 8, 15, 32]. Moreover, an improvement in the YYIR1 distance as a result of high-intensity interval training was associated with greater match-running distance at high-speeds [24]. On the other hand, the YYIR2 intensely taxes both aerobic and anaerobic energy systems and assesses the ability to repeat high-intensity running with an almost maximum aerobic energy production [25]. Thus, the YYIR2 has been suggested as a more effective test than the YYIR1, especially amongst elite players [29]. In support, the YYIR2 possesses a high reproducibility and is sensitive to measuring changes in the ability to perform intense intermittent activities both between and within seasons [25]. However, the construct validity of the YYIR2 test has not been examined in youth soccer players and the identification of valid field tests would benefit coaches and sport scientists in the development of talent selection procedures and to monitor the training process [21].

Match-running performance has been extensively studied in elite youth soccer players [4, 16, 17, 20, 34, 37] and such performance has been demonstrated to be playing position-dependent [4, 27, 34, 37]. These studies reported that the lowest total match-running distance covered was by central defenders (CD), whilst central midfielders (CM) covered a greater total distance than any other playing positions [4, 37]. Furthermore, CD and CM exhibited less sprinting distance (> 5.3 $m \cdot s^{-1}$) than wide defenders (WD) and wide midfielders (WM) [4], whilst CD covered the lowest distance at high-speeds (≥ 5.5 $m \cdot s^{-1}$) compared to other playing positions [37]. Since match-running performance differs between playing positions, it is important to compare the relationships between field test performance and match-running performance across playing position.

In youth soccer, match-running performance has typically been examined by measuring the distance covered by players within certain speed zones (i.e. the speed approach) [4, 16, 17, 20, 34, 37]. In recent years, metabolic power has been suggested as an alternative estimate of the physical demands during match-play (i.e. the metabolic power approach) [30], and match-running performance has previously been analyzed with the metabolic power approach in youth soccer players [15, 17]. Unlike the speed approach, estimations of metabolic power enable the energy expenditure of very high-intensity, short duration running phases such as accelerations and decelerations to be quantified [30]. However, to the best of the authors' knowledge, match-running performance data across playing position and analyzed using the metabolic power approach has not been reported in youth soccer. Such data may support coaches and sports scientists to create playing position-specific training programs for youth soccer players.

It has recently been suggested that the profile of acceleration and deceleration during match-play is playing position-dependent [22, 38] and is more sensitive to fatigue than running distance analyzed using the speed approach [1, 22, 33, 38]. Hence, examining the relationships between the YYIR2 performance and acceleration and deceleration-related match performance may extend the knowledge regarding construct validity of the YYIR2 as a measure of match-running performance. Therefore, the aims of the present study were to examine: 1) match-running performance across playing position using the metabolic power approach in elite youth soccer players; and 2) the relationships between the YYIR2 performance and match-running performance across playing positions. We hypothesized that the YYIR2 performance and match-running performance are playing position-dependent.

Materials and Methods

Participants

The participants were 129 elite outfield players from 11 Japanese professional soccer club academy teams, of which six were Japanese international players (age = 17.0 ± 0.8 years; height = 171.0 ± 5.8 cm; body mass = 64.0 ± 5.3 kg [mean ± SD]). In each week during the season, the players typically participated in five 2-hour training sessions and a competitive match (Saturday or Sunday). All players generally participated in all training sessions and matches, and the players who missed more than two training sessions and/or matches were not included in the study. The players were provided with a written and verbal explanation of the study including all measurements to be taken. Each player signed an informed assent form and completed a health screen questionnaire prior to participation in the study. A parent of each player signed a consent form prior to the start of the study. Players were instructed both verbally and in writing that they were free to withdraw from the study without giving any reasons and without any penalty regarding their position within the soccer club. Participants were withdrawn from the study if they did not have a satisfactory health status. The study was approved by a University Ethics Committee (ethics number: 2017-19).

Match analysis

A total of 26, 11-a-side official league matches were analyzed and the players were categorized as central defenders (CD, N = 35), wide defenders (WD, N = 29), central midfielders (CM, N = 29), wide midfielders (WM, N = 17), and strikers (ST, N = 19). All matches were played on international match size (length = 100-110 m, width = 64-75 m, Fédération Internationale de Football Association (FIFA)) flat artificial grass pitches (third generation astroturf). Match durations were of standard length (90 min plus additional time) and playing formation was consistent throughout the match. The players were required to play a full match in the same playing position for the whole match to be included in the analysis and all matches started and finished with 22 players.

Match-running performance

The match-running performance of each player was analyzed by assessing the distances covered in different speed zones and metabolic power zones. The speed zones were as follows: high-intensity running (HIR, 3.6 to 4.4 $m \cdot s^{-1}$); very high-intensity running (VHIR, 4.5 to 5.3 $m \cdot s^{-1}$); sprinting (> 5.3 $m \cdot s^{-1}$); and very high-intensity activity (VHIA, calculated as VHIR plus sprinting) [4]. Metabolic power was analyzed as described previously [30] and metabolic power zones were as follows: high power (HP, 20-35 $W \cdot kg^{-1}$); elevated power (EP, 35-55 $W \cdot kg^{-1}$); maximal power (MaxP, > 55 $W \cdot kg^{-1}$); and MP≥35 (calculated as EP plus MaxP) [26, 30]. Moreover, the number of accelerations (> 2 $m \cdot s^{-2}$) and decelerations (< 2 $m \cdot s^{-2}$) were counted. Acceleration had to exceed and remain above the limit for at least 0.8 s to be included and the same events applied for decelerations with negative signs [28, 38]. The data were expressed in relative terms (per 90 min) as match duration was statistically different across playing position when additional time was included.

Match-running performance was analyzed with 15 Hz (5 Hz interpolated to 15 Hz) GPS technology (SPI HPU, GPSports, Canberra, Australia) which was positioned on the upper back in a custom-made vest. This device has been reported to possess a sufficient validity and reliability to analyze distance covered at various speeds, metabolic powers, accelerations and decelerations in a team sport set up [23, 31, 36]. At least 8 satellites (mean ± SD = 9.9 ± 0.8 satellites) were connected during data collection which is the minimum number of satellites required to allow an accurate measurement [36, 39]. The match-running performance outcomes were calculated using Team AMS software version R1.2019.1 (GPSports, Canberra, Australia).

The Yo-Yo intermittent recovery test level 2

The YYIR2 was conducted within 3 weeks of the matches during the season. All players were familiarized to the YYIR2 test and the tests took place on the outdoor artificial grass pitches where the matches were played. The test involved repeated 20 m shuttle runs and the running speed was increased progressively with audio sound signals from a laptop computer. The players were given 10 s between each shuttle run to jog around a cone placed 5 m behind the finish line before returning to the start line. The test was terminated when a player failed to complete the shuttle run in time on two occasions. The distance covered in the last complete successful shuttle

was recorded as the test score [25].

Statistical analyses

Normality of the data was examined by the Kolmogorov-Smirnov test and homogeneity of variance was assessed with Levene's test. One-way analysis of variance (ANOVA) with Bonferroni's post-hoc test was employed to examine differences between playing positions in the YYIR2 distance and match-running performance. Log transformation was conducted whenever normality of the data was violated [14]. When the data were normally distributed but variances were unequal, ANOVA with Games-Howell post-hoc test was employed [14]. Partial eta-squared (η^2) was determined as measures of effect size when ANOVAs were employed and the values were considered as small (0.01), medium (0.06) and large (0.15) [9].

Pearson's product-moment correlations (r) were calculated to examine the relationships between the YYIR2 distance and match-running performance variables. The magnitude of correlation coefficients were considered as trivial (r = 0.0), small (r = 0.1) moderate (r = 0.3), large (r = 0.5), very large (r = 0.7), nearly perfect (r = 0.9) and perfect (r = 1) [19]. The level of statistical significance was set at $P < 0.05$. Results are presented as mean ± SD, whilst 95% confidence intervals (CI) were determined where appropriate. All statistical analyses were performed using SPSS version 22.0 (IBM SPSS statistics for Windows, IBM, Armonk, New York, USA).

Results

The YYIR2 distance and match-running performance of all players and across playing position are presented in Table 1. There were no differences between playing positions in the YYIR2 distance ($P = 0.907$). When match-running performance was analyzed with the speed approach, CD covered less total and HIR distance than WD, CM and WM, whilst ST covered less total and HIR distance than CM and WM (all $P < 0.05$, $\eta^2 = 0.39$-0.46). CD and ST demonstrated 21-37% less VHIR distance than WD, CM and WM (all $P < 0.01$, $\eta^2 = 0.53$). Moreover, CD sprinted 32-59% less distance than all the other playing positions, whilst CM and ST sprinted 31-39% less distance than WD (all $P < 0.01$, $\eta^2 = 0.60$). For VHIA, CD covered 28-47% less distance than all the other playing positions, CM covered 20% less distance than WD, and ST covered 22-27% less distance than WD and WM (all $P < 0.05$, $\eta^2 = 0.62$). When match-running distance was analyzed with the metabolic power approach, CD and ST covered 17-29% less HP distance than WD, CM and WM (all $P < 0.05$, $\eta^2 = 0.41$). CD showed 22-34% less EP distance than WD, CM and WM, and CM and ST demonstrated 16-24% less EP distance than WD (all $P < 0.01$, $\eta^2 = 0.50$). Moreover, CD and CM covered 34-43% less MaxP distance than WD, WM and ST (all $P < 0.01$, $\eta^2 = 0.47$). Furthermore, CD exhibited 19-37% less MP≥35 distance than all the other playing positions, whilst CM and ST showed 19-22% less MP≥35 distance than WD (all $P < 0.05$, $\eta^2 = 0.52$). In addition, CD accelerated 23% less frequently than WM ($P = 0.002$, $\eta^2 = 0.17$) and decelerated 22-29% less frequently than WD, CM and ST (all $P < 0.01$, $\eta^2 = 0.30$).

		All players	***CD***	***WD***	***CM***	***WM***	***ST***	η^2
N		129	35	29	29	17	19	
YYIR2 (m)	Mean	1007	968	1020	1021	1027	1023	0.01
	SD	232	239	231	204	241	275	
Total distance (m)	Mean	10664	9774^{a*b*c*}	11012	11282^{d*}	11153^{d}	10345	0.46
	SD	914	711	657	677	734	670	
HIR (m)	Mean	1450	1238^{ab*c*}	1455	1702^{d*}	1627^{d*}	1260	0.39
	SD	304	216	183	242	314	289	
VHIR (m)	Mean	804	601^{a*b*c*}	894^{d*}	913^{d*}	961^{d*}	704	0.53
	SD	200	68	161	169	184	113	
Sprinting (m)	Mean	730	437^{a*b*c*d*}	1063^{b*d*}	644	880	733	0.60
	SD	300	109	272	182	268	172	
VHIA (m)	Mean	1533	1038^{a*b*c*d*}	1957^{b*d*}	1557	1841^{d}	1437	0.62
	SD	451	127	396	293	399	241	
HP (m)	Mean	1955	1712^{a*b*c}	2074^{d}	2241^{d*}	2132^{d}	1592	0.41
	SD	386	248	263	270	422	374	
EP (m)	Mean	756	596^{a*b*c*}	909^{b*d*}	767	853	694	0.50
	SD	169	72	151	121	173	120	
MaxP (m)	Mean	280	203^{a*c*d*}	359^{b*}	219^{c*d*}	342	330	0.47
	SD	101	50	93	71	96	85	
MP≥35 (m)	Mean	1036	798^{a*b*c*d*}	1268^{b*d}	986	1194	1023	0.52
	SD	249	96	235	174	240	181	
Accelerations (counts)	Mean	94	83^{c}	97	96	108	95	0.17
	SD	20	17	21	17	23	15	
Decelerations (counts)	Mean	105	86^{a*b*c*}	117	110	122	98	0.30
	SD	25	17	25	21	29	17	

Significantly different at $p < 0.05$ vs. a: WD, b: CM, c: WM, d: ST. *P < 0.01. CD = central defenders, WD = wide defenders, CM = central midfielders, WD = wide midfielders, ST = strikers, YYIR2 = Yo-Yo intermittent recovery test level 2, HIR = high-intensity running, VHIR = very high-intensity running, VHIA = very high-intensity activity, HP = high power, EP = elevated power, MaxP = maximal power, MP≥35 = metabolic power greater than or equal to 35 $W \cdot kg^{-1}$.

Table 1: The YYIR2 distance and match-running performance of all players and across playing position.

When all players were included in the analysis, there were positive relationships between the YYIR2 distance and all match-running performance variables (r = 0.30-0.47, all P < 0.01, Figure 1-3). When each playing position was analyzed separately, the YYIR2 distance showed positive relationships with: total distance in CD (r = 0.48, P = 0.016); VHIR distance in WD (r = 0.53, P = 0.023); sprinting distance in CM and ST (r = 0.68-0.75, all P < 0.05); and VHIA in WD, CM, WM and ST (r = 0.49-0.69, all P < 0.05) (Figure 1).

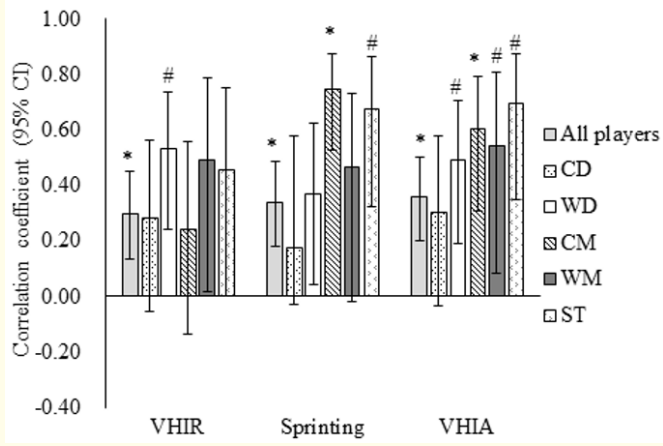

Figure 1: Correlation coefficients (95% CI) between the YYIR2 distance and VHIR, sprinting and VHIA distance. Significantly correlated to YYIR2 distance at #P < 0.05 and *P < 0.01. CD = central defenders, WD = wide defenders, CM = central midfielders, WD = wide midfielders, ST = strikers, YYIR2 = Yo-Yo intermittent recovery test level 2, VHIR = very high-intensity running, VHIA = very high-intensity activity.

Moreover, the YYIR2 distance illustrated positive relationships with: EP distance in CD, WD, WM and ST (r = 0.52-0.78, all P < 0.05); MaxP distance in CD, WD, CM and ST (r = 0.48-0.64, all P < 0.05); and MP≥35 distance in all playing positions (r = 0.52-0.82, all P < 0.05) (Figure 2).

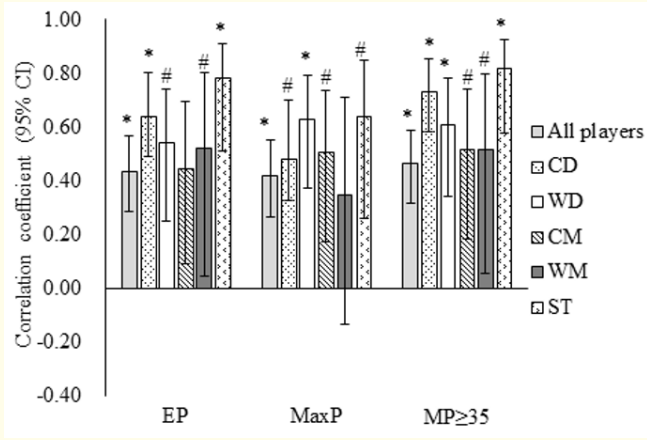

Figure 2: Correlation coefficients (95% CI) between the YYIR2 distance and distance covered during EP, MaxP and MP≥35. Significantly correlated to YYIR2 distance at #P < 0.05 and *P < 0.01. CD = central defenders, WD = wide defenders, CM = central midfielders, WD = wide midfielders, ST = strikers, YYIR2 = Yo-Yo intermittent recovery test level 2, EP = elevated power, MaxP = maximal power, MP≥35 = metabolic power greater than or equal to 35 $W \cdot kg^{-1}$.

In addition, there were positive relationships between the YYIR2 distance and number of accelerations and decelerations in CD and WD (r = 0.53-0.83, all P < 0.05) (Figure 3). There were no other significant relationships between the YYIR2 distance and match running performance variables.

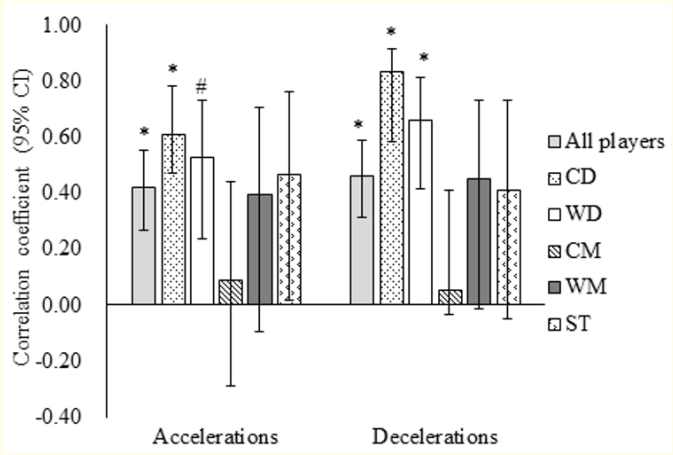

Figure 3: Correlation coefficients (95% CI) between the YYIR2 distance and number of accelerations and decelerations. Significantly correlated to YYIR2 distance at #P < 0.05 and *P < 0.01. CD = central defenders, WD = wide defenders, CM = central midfielders, WD = wide midfielders, ST = strikers, YYIR2 = Yo-Yo intermittent recovery test level 2.

Discussion

The current study is the first to describe match-running performance across different playing positions using the metabolic power approach in elite youth soccer players and the first to investigate the relationships between the YYIR2 distance and match-running performance across playing position. Moreover, the study extended previous investigations by including acceleration and deceleration-related variables in match-running performance. The key findings of the current study were that: 1) match-running performance based on metabolic power zones and the profile of accelerations and decelerations were playing position-dependent in elite youth soccer players; 2) moderate to large associations were observed between the YYIR2 distance and all match-running performance variables when all players were included in the analysis; 3) the YYIR2 distance revealed large to very large relationships with total distance in just CD and with running distance at high-speeds in all playing positions except CD; 4) large to very large relationships were demonstrated between the YYIR2 distance and distance covered by high-metabolic powers in all playing positions; and 5) the YYIR2 distance and number of accelerations and decelerations were largely related in defenders.

In the current study, the YYIR2 distance was around 1000 m regardless of playing position. This is similar to international (1059 ± 35 m) [25] and moderate (1050 m) [2] level senior soccer players. Moreover, there were no differences in the YYIR2 distance between playing positions which is similar to previous studies reporting only a small difference in the YYIR2 distance across playing position in professional soccer players [25], and a small difference in physical capacity across playing position in elite youth soccer players [4]. Furthermore, in the present study, total match-running distance and match-running distance analyzed using the speed approach were similar to previous studies [17, 20, 34, 37]. As previously reported in elite youth soccer players, total distance and distance covered in speed zone categories were playing position-dependent in the current study [4, 34, 37]. Similarly with the previous findings, CD covered less total distance and high-speed running distance compared to other playing positions [4, 34, 37], whereas midfielders tended to cover the longest total distance [4, 34, 37]. However, the greatest distance sprinted was by WD in the current study opposed to WD,

WM and/or ST in the previous studies [4, 34, 37]. This discrepancy may have occurred due to differences in the tactical requirement in these particular competitions, as tactical elements can differ between countries [10]. When match-running distance was analyzed using the metabolic power approach, distance covered was similar to that reported previously in elite youth [17] and professional [26, 30] soccer players. Similarly with match-running distance analyzed using speed approach, the present match-running performance data was playing position-dependent when the metabolic power approach was employed. In addition, CD accelerated less frequently than WM and decelerated less frequently than WD, CM and WM. Similar profiles of accelerations and decelerations in professional players have been reported previously [38]. These findings provide coaches and sports scientists with further insight to understand the match-running performance of elite youth soccer players and could assist them in providing position-specific training programs.

Moderate to large relationships between the YYIR2 distance and all match-running performance variables were demonstrated in the current study when all players were included in the analysis. This is in line with previous studies on youth soccer players which reported that physical capacity (assessed with the YYIR1) was significantly related to match-running performance variables such as total distance and match-running distance at high-speeds, high-metabolic powers, and high-intensity accelerations and decelerations [7, 8,1 5]. However, the previous studies failed to examine the relationships between physical capacity and match-running performance across playing positions [7, 8, 15] due to small sample sizes [32]. A large sample size is necessary to detect real systematic differences in performance characteristics, as there is a high match-to-match variability in running performance in soccer [18]. The current study extended these previous findings by assessing the relationships between physical capacity and match-running performance across playing position in elite youth soccer players.

The current findings demonstrated that the relationship between the YYIR2 distance and match-running performance differs between playing positions. In CD, a significant relationship between the YYIR2 distance and total distance was observed which is consistent with previous findings [7, 8, 15]. However, CD demonstrated no significant relationships between the YYIR2 distance and all match-running performance variables at high-speeds (HIR, VHIR, sprinting and VHIA). These findings are in contrast with previous studies reporting significant relationships between the YYIR1 distance and match-running distance at high-speeds [7, 8, 15]. This discrepancy may be due to the fact that these previous studies examined the relationships with mixed playing positions. CD covered the least distance at high-speeds during match play in both the current and previous studies, which may suggest that match-running distance at high-speeds is less important in CD compared to the other playing positions [4, 34, 37]. Moreover, as a major aim of CD is to defend their goal, movements of CD are restricted to certain strategic areas of the pitch which could mean that their running distance at high-speeds is limited [5]. Since the YYIR2 assesses the ability to repeat high-intensity running at an almost maximum aerobic energy production [25], the YYIR2 may not possess a sufficient construct validity as a measure of match-running distance at high-speeds in CD.

All playing positions except CD showed moderate to very large relationships between the YYIR2 distance and match-running distance at high-speeds. This finding was expected as similar outcomes have previously been reported [7, 8, 15]. However, the YYIR2 distance was related to VHIR distance in just WD and was related to sprinting distance in CM and ST only. These differences may be explained by the unique roles and responsibilities in each playing position. An ability to run repetitively at high-speeds is crucial for WD as they are often required to take up wide and advanced positions to join attacking build-up play [34], whereas CM have unique positional characteristics to link attack and defense within the team. Subsequently, this may require them to sprint in order to join the attack quickly or recover fast to defend against counter-attacks [11]. In addition, sprinting is necessary for ST to complete their key tasks such as capitalizing on goal scoring opportunities [12]. Therefore, the YYIR2 is the valid test for the assessment of match-running distance at high-speeds in WD, CM, WM and ST in elite youth soccer players.

The present findings demonstrated that the YYIR2 distance was largely to very largely related to match-running distance covered at high metabolic powers regardless of playing position. Given that significant relationships between the YYIR2 distance and match-running distance at high-speeds were not present in CD and the relationships were smaller than other playing positions in WD, the quantification of energy expenditure established much larger relationships between the YYIR2 and match-running performance, especially in CD. Indeed, high-metabolic powers reflect the energy expenditure of high-intensity actions by including accelerations and

decelerations [30]. This is partly supported by the current results which displayed large to very large relationships between the YYIR2 distance and the number of accelerations and decelerations in defenders. Therefore, the YYIR2 is a valid test for the assessment of match-running performance in elite youth soccer players regardless of playing position when match-running performance is analyzed using the metabolic power approach.

There are potential limitations of this study. In the current study, acceleration and deceleration frequencies were employed as match-running performance variables as they have been suggested as a sensitive measure of fatigue during soccer match-play [1, 22, 33, 38]. However, distance covered [1] and time spent [28] during accelerations and decelerations have also been suggested to reflect the demands of a soccer match. Moreover, significant relationships between physical capacity and distance covered during high-intensity accelerations and decelerations have been reported in youth soccer players [15]. Since the inclusion of such data was restricted in the current study due to a limited function in the match analysis software, an examination of associations between field test performance and various acceleration and deceleration variables across playing position should be considered in future investigations.

Conclusion

The current findings suggest that the YYIR2 test is a valid test for the assessment of match-related physical fitness in elite youth soccer players regardless of playing position. However, the relationships between the YYIR2 and match-running performance are playing position-dependent and the YYIR2 distance was related to total distance in only CD. Moreover, match analysis methods can influence the relationships as no significant relationships were observed between the YYIR2 distance and match-running distance at high-speeds in CD when speed approach was employed. Furthermore, the number of accelerations and decelerations was largely related to the YYIR2 distance in defenders only. On the other hand, the metabolic power approach generally demonstrated large to very large relationships between the YYIR2 distance and distance covered by high-metabolic powers in all playing positions. Therefore, the YYIR2 test should be considered as a valuable resource for coaching staff and sports scientists to monitor physical capacity of elite youth soccer players and to guide players to attain the required fitness to cope with match demands in order to step up to senior standard. However, match analysis methods should be carefully chosen as they may limit the associations between physical capacity and match-running performance.

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References

1. Akenhead R., et al. “Diminutions of acceleration and deceleration output during professional football match play”. J Sci Med Sport 16 (2013): 556-561.
2. Bangsbo J, Iaia FM and Krustrup P. “The Yo-Yo Intermittent recovery test. A useful tool for evaluation of physical performance in intermittent sports”. Sports Med 38 (2008): 37-50.
3. Buchheit M. “The 30-15 intermittent fitness test: Accuracy for individualizing interval training of young intermittent sport players”. J Strength Cond Res 22 (2008): 365-374.
4. Buchheit M., et al. “Match running performance and fitness in youth soccer”. Int J Sports Med 31 (2010): 818-825.
5. Buchheit M, Simpson BM and Mendez-Villanueva A. “Repeated high-speed activities during youth soccer games in relation to changes in maximal sprinting and aerobic speeds”. Int J Sports Med 34 (2013): 40-48.
6. Castagna C., et al. “Validity and reliability of the 45-15 test for aerobic fitness in young soccer players”. Int J Sports Physiol Perform 9 (2014): 525-531.
7. Castagna C., et al. “Effect of intermittent endurance fitness on math performance in young male soccer players”. J Strength Cond Res 23 (2009): 1954-1959.
8. Castagna C., et al. “Relationship between endurance field tests and match performance in young soccer players”. J Strength Cond Res 24 (2010): 3227-3233.

9. Cohen J. "Chapter 8: The Analysis of Variance and Covariance". Statistical power analysis for the behavioural sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum, (1988): 203-406.
10. Dellal A., et al. "Comparison of physical and technical performance in European soccer match-play: FA Premier League and La Liga". Eur J Sport Sci 11 (2011): 51-59.
11. Di Salvo V., et al. "Performance characteristics according to playing position in elite soccer". Int J Sports Med 28 (2007): 222-227.
12. Faude O, Koch T and Meyer T. "Straight sprinting is the most frequent action in goal situations in professional football". J Sports Sci 30 (2012): 625-631.
13. Fenarnandes da Silva J., et al. "The peak velocity derived from the Carminatti Test is related to physical match performance in young soccer players". J Sports Sci 34 (2016): 2238-2245.
14. Field A. "Chapter 11: Comparing several mans: ANOVA (GLM 1)". In: Discovering Statistics using IBM SPSS Statistics (4th ed.). London, UK: Sage Publications Ltd, (2013): 429-477.
15. Francini L., et al. "Association Between Match Activity, Endurance Levels and Maturity in Youth Football Players". Int J Sports Med 40 (2019): 576-584.
16. Goto H, Morris JG and Nevill ME. "Motion analysis of U11 to U16 elite English premier league academy players". J Sports Sci 33 (2015): 1248-1258.
17. Goto H and Saward C. "The Running and Technical Performance of U13 to U18 Elite Japanese Soccer Players During Match Play". J Strength Cond Res 34 (2020): 1564-1573.
18. Gregson W., et al. "Match-to-match variability of high-speed activities in premier league soccer". Int J Sports Med 31 (2010): 237-242.
19. Hopkins WG., et al. "Progressive statistics for studies in sports medicine and exercise science". Med Sci Sports Exerc 41 (2009): 3-13.
20. Hunter F., et al. "Individualisation of time-motion analysis: a method comparison and case report series". Int J Sports Med 36 (2015): 41-48.
21. Impellizzeri F, Rampinini E and Marcora SM. "Physiological assessment of aerobic training in soccer". J Sports Sci 23 (2005): 583-592.
22. Ingebrigtsen J., et al. "Acceleration and sprint profiles of a professional elite football team in match play". Eur J Sport Sci 15 (2015): 101-110.
23. Johnston RJ., et al. "Validity and interunit reliability of 10 Hz and 15 Hz GPS units for assessing athlete movement demands". J Strength Cond Res 28 (2014): 1649-1655.
24. Krustrup P and Bangsbo J. "Physiological demands of top-class soccer refereeing in relation to physical capacity: Effect of intense intermittent exercise training". J Sport Sci 19 (2001): 881-891.
25. Krustrup P., et al. "The Yo-Yo IR2 test: physiological response, reliability, and application to elite soccer". Med Sci Sports Exerc 38 (2006): 1666-1673.
26. Manzi V, Impellizzeri F and Castagna C. "Aerobic fitness ecological validity in elite soccer players: a metabolic power approach". J Strength Cond Res 28 (2014): 914-919.
27. Mendez-Villanueva A., et al. "Match play intensity distribution in youth soccer". Int J Sports Med 34 (2013):101-110.
28. Newans T., et al. "Modelling the Acceleration and Deceleration Profile of Elite-level Soccer Players". Int J Sports Med 40 (2019): 331-335.
29. O'Reilly J and Wong SH. "The development of aerobic and skill assessment in soccer". Sports Med 42 (2012): 1029-1040.
30. Osgnach C., et al. "Energy cost and metabolic power in elite soccer: A new match analysis approach". Med Sci Sports Exerc 42 (2010): 170-178.
31. Rampinini E., et al. "Accuracy of GPS devices for measuring high-intensity running in field-based team sports". Int J Sports Med 36 (2015): 49-53.
32. Rebelo A., et al. "Physical match performance of youth football players in relation to physical capacity". Eur J Sport Sci 14 (2014): S148-S156.

33. Russell M., et al. "Changes in acceleration and deceleration capacity throughout professional soccer match-play". J Strength Cond Res 30 (2016): 2839-2844.
34. Saward C., et al. "Longitudinal development of match-running performance in elite male youth soccer players". Scand J Med Sci Sports 26 (2016): 933-942.
35. Stolen T., et al. "Physiology of soccer: An Update". Sports Med 36 (2005): 501-536.
36. Varley MC, Fairweather IH and Aughey RJ. "Validity and reliability of gps for measuring instantaneous velocity during acceleration, deceleration, and constant motion". J Sports Sci 30 (2012): 121-127.
37. Varley MC., et al. "Physical and technical performance of elite youth soccer players during international tournaments: influence of playing position and team success and opponent quality". Sci Med Football 1 (2017): 18-29.
38. Vigh-Larsen JF, Dalgas U and Andersen TB. "Position-specific acceleration and deceleration profiles in elite youth and senior soccer players". J Strength Cond Res 32 (2018): 1114-1122.
39. Waldron M., et al. "Concurrent validity and test-retest reliability of a global positioning system (GPS) and timing gate to assess sprint performance variables". J Sports Sci 29 (2011): 1613-1619.